Indian Forest Bulletin No. 193

(New Series)

Mycology

PRINCIPLES OF TREE DISEASE CONTROL WITH REFERENCE TO INDIAN FORESTS

BY

B. K. BAKSHI

Mycologist, Forest Research Institute, Dehra Dun

सत्यमेव जयते

(Reprinted from *The Indian Forester*, Vol. 81, No. 10, pages 653–657, 1955)

PUBLISHED BY THE MANAGER OF PUBLICATIONS, DELHI
PRINTED AT THE OFFICE OF THE GEODETIC AND RESEARCH BRANCH
SURVEY OF INDIA, DEHRA DUN, 1956

Price As. -/8/- or 9 d.

PRINCIPLES OF TREE DISEASE CONTROL WITH REFERENCE TO INDIAN FORESTS*

BY B. K. BAKSHI

Forest Research Institute, Dehra Dun

A forest crop has a low value per unit area as compared to an agricultural crop. The intensive methods of control of diseases by chemicals, etc., outlined for an agricultural crop are, therefore, not economical in forestry practice. Control of tree diseases is thus largely limited to what can be accomplished during silvicultural operations, which keep the disease incidence to a minimum. Thus tree vigour has to be maintained as suppressed trees lose the natural resistance inherent in healthy trees and are liable to attack by parasites. Seeds should be collected from healthy mother trees to raise healthy stands from them. In natural regeneration, the choice of seed trees to be left in the felling areas is a thing which may have a large influence on the subsequent hereditary composition of the stand. Improvement thinning and selection felling eliminate poor lines by removing the weak, suppressed and diseased trees and decrease competition by eliminating overcrowding so that the trees left in the stand develop more vigorously than before. Maintenance of sanitary conditions in forests is necessary like removal of diseased trees and disposal of slash to prevent breeding ground of parasites. With these, the fruiting bodies of fungi, if formed, are also removed and the sources of infection and spread of the disease are minimized. Regulations regarding control burning and prevention of fire are important steps towards disease prevention since injury to trees caused by fire is an important avenue of entry of many fungi causing tree diseases. Quarantine rules prevent the introduction of diseased plant materials into a country and thereby the local forests are not threatened by introduced diseases.

India has a vast wealth of tree species, most of which are native to the land they occupy. In recent years, exotics are tried in different parts of India but many of these have not been successfully established. Though the causes of failure are not known in many cases, it may be said that in general, the failure of exotics is usually due to unsuitable environment. The exotics again do not get adjusted to the parasites in their new homes, so that the hazards from parasites which are of minor significance on native species may become severe on introduced exotics. The chances of success in introducing exotics are much smaller than those of failure and they should be introduced only if they fulfil some definite need not met by indigenous species.

During their growth in the forests for long years, the native species have developed an equilibrium with the local parasites. Sound silviculture along the lines mentioned above will lead to growth of healthy forests. In spite of this, diseases break out in the forest and assume a proportion which call for attention of the pathologists. Foresters are concerned with quick solution of a disease, failing to realize the fundamental problems that have to be answered in connection with a disease before its control can be suggested. Tree diseases cannot be investigated with the ease or speed with which results can be obtained on diseases of agricultural crops. The following account gives the principles in the control of some important Indian tree diseases.

Diseases due to non-parasitic troubles – problems of tree nutrition and tree vigour— A striking example of a disease due to non-parasitic troubles is that of *Casuarina equisetifolia*

* Based on the paper presented to the Fourth World Forestry Congress, 1954.

which is widely planted along sea-coasts and also inland areas in South India. At present, vast areas of coastal plantations are a complete failure, due to deficiency of nutrition in an otherwise barren substratum like sand which is also deficient in moisture due to uncertainty and failure of monsoons and also incapability of coarse sand particles to raise water from water-table to surface where majority of the roots lie (Bakshi, 1951). Drought acts as a limiting factor in the development of nodules on roots which as a result wither and die and thus the only source of replenishing an otherwise barren substratum with nitrogen by nitrogen-fixing bacteria is also lost. Control measures to raise healthy stands should be directed to increase the vigour of the plants at the seedling stage which may be obtained by manuring seedlings, watering for the first two years and deep planting among other methods (Bakshi, 1951). Casuarina is one of the few species raised successfully on coastal areas to fix sand dunes, prevent soil erosion, etc. Due to short rotation of casuarina which is usually 7–10 years, there is justification in adopting intensive control measures as practiced with agricultural crops.

Effects of injury—Wounds inflicted artificially on trees due to pruning, lopping, etc., are footholds through which parasites enter the trees. Thus *Trichosporium vesiculosum* establishes in a casuarina plantation by infecting trees through injury caused during pruning (Bakshi, 1951). *Fomes pini* (= *Trametes pini*) which takes heavy toll on blue pine (*Pinus excelsa*) enters the trees through wounds caused by illicit lopping of branches. *Fomes senex*, *F. rimosus* and *F. badius* attack important trees in forests and avenues through injuries (Bagchee and Bakshi, 1950). These fungi do not usually attack the sapwood but decay the merchantable heartwood so that in advance stages of attack, the affected trees are liable to wind-throw. Pruning and lopping have to be stopped to secure control from wound parasites. Public opinion has to be created so that valuable trees on the road sides, parks and gardens are not mutilated and damaged.

Fire and frost may predispose trees to fungus attack. Fire is a decidedly injurious factor and many fungi gain entrance through fire scars. Fire burns the leaf-litter and thus the humus which is so much necessary for healthy plant growth is lost. Prevention of fires or control burning is thus necessary. Frost may cause injury in the form of cankers on stems through which fungi may find access into trees. *Dalbergia latifolia*, a southern species, when grown in the north, suffers from frost cankers through which *Polyporus gilvus* enters the trees and causes saprot.

Sanitation and hygiene—A diseased tree standing in the forest continues to be a source of potential danger to the neighbouring healthy trees to which the disease may pass through the soil by root contact or root grafting as in secondary spread of *Trichosporium vesiculosum* in plantations of casuarina. This danger becomes particularly alarming if, on the diseased tree, the parasite develops fruiting bodies in which spores are formed which are carried by wind or other agencies and serve as a means of infection and rapid spread of the disease. All diseased trees should therefore be removed during thinning and those bearing heavily sporing fungi should be burnt. The diseased trees after they are cut, should not be stacked in the forest or else they will serve as the breeding ground of fungi and insects. The disposal of slash is necessary for similar reasons. The 'gauj' disease of sal due to *Fomes caryophylli* can be controlled by sanitation cutting. Again parasites which do not attack standing trees may colonise their stumps and thus build up to a large proportion in the forests which may endanger the health of the future stand. Stump infection can be prevented by coating the cut ends of stumps with a preservative like creosote soon after felling as is done in the control of *Fomes annosus* (Rishbeth, 1952). Where coppicing is practiced, care should be taken to see that diseased stumps do not coppice, otherwise the disease will be transmitted to the coppiced shoot. *Fomes caryophylli* on sal is transmitted in this way. Hence the stumps should be carefully inspected for presence of any rot due to *F. caryophylli* before it is allowed to coppice.

Problem of alternate host—Heteroecious tree rusts which usually attack conifers have fortunately, in most cases, an alternate host in a herbaceous species of no economic importance. The spore forms that develop on the latter have low range of aerial dissemination so that the principle in the control of such rusts lies in the eradication of the herbaceous host from the conifer forest and its vicinity up to a distance, which will depend on the range of dissemination of spores that develop on the herbaceous host. Unable to find the alternate conifer hosts, such spores fail to secure an infection and the conifers are saved from the rust disease. Thus *Cronartium himalayense*, a parasite on *chir* (*Pinus roxburghii*) requires herbaceous weed hosts belonging to some species of *Swertia* to complete its life-cycle (Bagchee 1933). If the *Swertia* spp. are eradicated from the *chir* forest and its vicinity up to a distance of 200 yards from the edge of the plantation for three successive years, the rust disease can be controlled (Bagchee, 1944). Similarly, *Cronartium ribicola*, the rust on blue pine (*Pinus excelsa*), has its alternate host on *Ribes*. Eradication of the latter will serve to eliminate the disease.

Soil conditions and disease incidence—The fundamental cause of many tree diseases is to be found in the state of the soil. The soil harbours a large number of parasites which are normally harmless under good conditions of growth of the trees, but become pathogenic when plants are grown under conditions adverse to their growth but favourable to development of the parasites. The basis of parasitism is to be found in the physical state of the soil of which the texture, water content and pH are most important. These factors may influence the microbial equilibrium of the soil and disturb it to the extent that the parasite becomes pathogenic on trees. Thus the high incidence of disease of deodar (*Cedrus deodara*) due to *Fomes annosus* is correlated with the aspect of the hill, unsuitable site and lack of proper aeration of roots due to soil texture which lead to death of roots. *Fomes annosus* enters mainly through the dead roots and then invades living roots, killing the trees eventually. Wilt of *shisham* (*Dalbergia sissoo*) caused by *Fusarium solani* (Bakshi, 1954, 1955 ; Bakshi and Sujan Singh, 1954), is common in stiff and clay soils which are unsuitable for proper root development and root aeration ; while in loose sandy soils as in riverain beds, the disease is absent though the fungus causing the wilt is present in such soils. Loose soils with consequent aeration of roots appear to be important in the healthy growth of *shisham* free from root diseases. Proper site selection for the growth of a plant species is thus important. *Ganoderma lucidum*, *G. applanatum*, *Polyporus gilvus* which attack various hardwoods (Bagchee and Bakshi, 1950) are some of the important root parasites which are soil borne. It is evident that the control of soil borne diseases presents one of the most difficult problems. The physico-chemical factors of the soil which provide conditions under which the biotic factors play their role in disease incidence should be studied before control measures can be suggested. Allied to these are the problems of the restoration of soil fertility, the influence of cover crops and crop rotation. It must be remembered that root diseases caused by fungi which are universally present in soil cannot ordinarily be controlled by crop rotation since these fungi continue to persist in the soil even in absence of the host. *Fusarium solani*, causing wilt of *shisham*, is an instance to this (Bakshi, 1955). The crops in rotation may, however, possess an adverse effect on the parasites in the soil by becoming antagonistic to the latter. The usefulness of crop rotation may be seen in such cases.

Pure and mixed stands—Due to greater economic value of a species over its natural associates, there is a tendency to grow the former in a pure stand, in which case, the silviculture is also rendered simple. In the natural forests of the Himalayas, conifers grow in mixtures with oaks and other hardwoods. Though Indian oaks are not economically important, some of them are of great use as nurses to and companions of the more important conifers and also act as an efficient soil protector and add humns to the soil. In plantations, conifers grown as

a pure stand due to economic value are known to thrive well but such pure stands of species which in nature occur in mixture, may ultimately lead to soil deterioration. Pure stands of deodar are known to suffer from root disease due to *Fomes annosus*. In the plains, mixed plantations are practised in *taungyas* under agriculture-cum-forestry management. A mixed stand is usually desirable over a pure one from pathological point of view since in the outbreak of a disease, its spread is rapid from tree to tree in case of a pure stand and nothing is left of the crop at the end. An example of this is afforded in the pure stands of casuarina. *Trichosporium vesiculosum* which causes wilt disease in casuarina, attacks the roots and infects the adjoining healthy trees by means of root contact and root grafting, features which are common among forest trees. Consequently the spread of the disease is rapid and leads to the occurrence of the diseased trees in groups (Bakshi, 1951). Trenching out diseased trees so as to sever connections of roots of diseased trees with those of adjoining healthy ones is the best method of checking rapid spread of the wilt disease of casuarina. In a mixed stand, if the disease appears on one species, it is unlikely to spread to its associates, since the fungal parasites usually have a restricted host range. A mixed plantation with suitable choice of species in the stand is thus desirable both from silvicultural and pathological point of view.

Felling age—The aim of forest pathology in timber production is to bring the forest stands through to maturity in a disease-free condition. In a young stand, increment of growth of a tree due to formation of new wood is rapid while the timber is relatively free from decay. With increasing age of the stand, the increment of new wood slows down gradually while the decay in timber increases rapidly so that a stage is reached when the volume of wood decayed overtakes and then surpasses the new wood added to the tree. From this stage, the tree suffers from an increasing net loss year after year. Such loss can be prevented by determining the age for each species at which decay becomes of economic importance and fell the trees before that age is reached. Instances of losses in overmature stands due to decay of heartwood are common but determination for the felling age for Indian species from pathological view-point has not been done. Until such studies are made, the role of decay in the management of these species will be largely a guess-work.

The object in presenting this article has been to emphasize the role that forest pathology plays in bringing the forest stands through to maturity in a disease-free condition and in producing crops of healthy timber. Notwithstanding the importance of the subject, the attention that is given to the study of forest pathology in India is inadequate. The Forest Research Institute at Dehra Dun is the only organization where problems relating to tree diseases are tackled in addition to those on timber pathology. In a vast country like India, the problems in forest pathology are many, while the staff engaged in studying the problems is inadequate. Forests constitute a primary source of income in many States and it is surprising that no State undertakes any work in forest pathology though every State has a team of workers in plant pathology to deal with any eventualities that may appear in agricultural crops. New records of tree diseases are now brought to light in India, the potentialities of which must be ascertained by survey work since many of them are known to cause serious losses to trees and timber in other countries. Losses incurred on our timber wealth have to be assessed. Works on mycorrhiza, seed selection, breeding trees resistant to diseases have to be initiated. The advancement of forest pathology in India is imperative if the health of our forests has to be maintained.

References

Bagchee, K. (1933). Investigations on the infestation of *Peridermium himalayense* Bagchee on *Pinus longifolia* II. *Cronartium himalayense* n. sp. on *Swerita* spp. Distribution, morphology of the parasite, pathological study of the infection, biological relationship with the pine rust and control. *Indian Forest Records*, **18**, 1–66.

Bagchee, K. (1944). The blister rust menace on *chir* in Kumaon. *Indian Forester*, **70**, 323–325.

Bagchee, K. and Bakshi, B. K. (1950). Some fungi as wound parasites on Indian trees. *Indian Forest Records* (New Series) Mycology, **1**, 1–10.

Bakshi, B. K. (1951). Mortality of *Casuarina equisetifolia* Forst. *Indian Forester*, **77**, 269–276.

—— (1954). Wilt of *shisham* (*Dalbergia sissoo* Roxb.) due to *Fusarium solani* sensu Snyder and Hansen. *Nature*, **174**, 278–279.

—— (1955). Wilt disease of *shisham* (*Dalbergia sissoo* Roxb.) II Behavior of *Fusarium solani*, the wilt organism, in soil. *Indian Forester*, **81**, 276–281.

Bakshi and Sujan Singh (1954). Wilt disease of *shisham* (*Dalbergia sissoo* Roxb.) I. Introduction and host parasite relationship. *Indian Forester*, **80**, 316–322.

Rishbeth, J. (1952). Control of *Fomes annosus* Fr. Forestry, **25**, 41–50.

G. & R.B.—P.O.—J.S. 502—3-10-55—390 bks.